ASSESSMENT OF WETLAND AREAS AT SHKODRA LAKE, ALBANIA SIDE

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ABSTRACT

Shkodra Lake is an ecosystem of importance for Albania and the region, in terms of history, culture and nature. The lake, in addition to its size as the largest in Albania, has great values for biodiversity and economic development. Along its eastern shores there are many wetlands. These areas are quite rich in plant and animal species and a variety of habitats. At the same time, these habitats are important for the local community, where they live and develop a large part of their vital activity. The wetland part is always under the influence of the rise and fall of the lake level due to seasonal changes. This project focuses on the study of new development alternatives that are more sustainable from an environmental point of view in Shkodra Lake, with the possibility of development in a long time, based on local natural resources but not harming them is necessary. For many decades, wetland areas have been treated as spaces that need to be changed, without economic value, dangerous for people's health, etc. With this study, it is required to evaluate numerically and not only qualitatively from the economic point of view of the wetland areas, combining it with the natural values. This study, which includes different study disciplines, will help to better known wetland areas not only from the environmental, natural, but also economic value. Traditionally, the lake pollution has been extensively studied regarding physical and chemical characteristics. However, lately microbiological quality of the lake has come under greater focus owing to deleterious effects of pollution on human health. The bacterial pollution of the water of Shkodra Lake, Albania part is conditioned both from the untreated sewage wastewater and the contribution of bathing people. Out of large number of microbial parameters linked with human health, some significant contaminating indicators, namely, total *Coli form* (MPN/100ml), *Faecal coliform* (MPN/100ml), *Streptococcus faecalis* (MPN/100ml) have been identified and measured. The results taken by the analyses show that the bacterial pollution of the littoral waters of Lake Shkodra, surpasses the UNEP/WHO standards for the microbiological quality of bathing waters (100-1000 *E. coli*/100ml) in most of the sampling locations.

Key words: biodiversity, pollution, microbiological quality, total coliform, *E. coli*.

INTRODUCTION

Shkodra Lake, the largest in the Balkans with an area of 369 km2, of which only 169 km2 are in the territory of our country. Albania is one of the Mediterranean countries where, until the 1940s, the wetland ecosystem was

established over a rich and connected network of wetland areas. In the early 1950s, the coastal area of Albania included 250,000 ha of natural spaces, of which 60,000 ha were marshlands. After the 1950s, the Albanian wetlands were radically changed through the promotion of the reform of the draining of the swamps and the extension of agricultural lands to the forested areas of the banks. More than 50% of the coastal wetlands as well as most of the deep marshlands were lost during the drying process. These works led to loss and fragmentation of natural environments (habitats) and deterioration of habitats and impoverishment of flora and fauna.

The area of areas with natural water reaches 2.3% of the territory, while areas with unnatural water represent 0.5% of the territory. Wetlands occupy about 90,000 ha or 3.2% of the national territory.

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In Albania, there are 5 types of lagoons based on the origin of their creation and function. The area with the largest area is formed by hydropower lakes, followed by natural lakes (of tectonic, glacial, or karst origin) and (5) coastal wetland systems. In these territories are found more than 70% of the country's vertebrates, especially birds, reptiles, and mammals. About 65 of the vertebrates of the wetlands have been identified as globally threatened species such as the Dalmatian Pelican or the Little Carabulla.

At least six wetlands (Shkodra Lake, Karavasta Lagoon, Narta Lagoon, Butrint Lake, Ohrid Lake and Prespa Lake) are potential Ramsar sites; to date only three of them (Karavasta Lagoon, Lake Butrint and Lake Shkodra) are recognized as Ramsar. Albanian wetlands represent the most sensitive and important environment in Albania. These are areas of multiple economic and ecological value and benefit, as they provide natural habitats for fish and wildlife, support complex food webs, absorb water thereby reducing flooding and storm damage, provide erosion control, improve water quality water, and equip the place with spaces of aesthetic value (Clarke S. 2001). Coastal lagoons, being special ecosystems between sea and land, are estimated to be the most productive aquatic ecosystems.

Domestic market demand for these products spurred increased investment in basket and tank farming. Littoral aquaculture is well developed in the southern region of the country, which has even more chances for the expansion of this activity. The development of this sector, however, is facing difficulties in the supply of food for fish and fry. Lagoons create good opportunities for the development of ecotourism (V. Pulevic, 2001). Beautiful landscapes combined with natural environments and special birds constitute a very interesting attraction for tourists. Albania's bright sun shines over some 450 kilometers of relatively unspoiled coastline. However, although there has recently been an improvement in roads and means of transport, the infrastructure is still insufficient to cope with the growing number of visitors. Nowadays the main thrust on natural wetland systems comes from the local population in areas of uncontrolled urban development. In some lagoons there are continuous discharges of fresh water such as artesian wells, channels communicating with rivers or water flows from catchments. In the last 10 years, with the help of the donor community, a series of activities have been undertaken for the protection and administration of wetland areas.

MATERIALS AND METHODS

This study was conducted using modern methods for water's lake, based on the guidelines of the World Health Organization and the European Community. For a better assessment of the quality of the monitored shore environments, a hygienic-sanitary inspection was carried out to determine the sources of pollution and to determine the microbial load of water and shore.

Based on the European Community Directive 2006/7 /EC, bank samples were protected from exposure to sunlight (WHO 1995). Samples were stored at a temperature of approximately 4 ºC, in the thermos until arrival at the laboratory. Samples were analysed on sampling day.

Hygienic-sanitary inspection was carried out to determine the sources of pollution at the selected points for monitoring (determination of urban discharges and used waters that flow directly or indirectly into the shore). Of great importance, in addition to determining the microbial load as the main indicator in assessing the degree of cleanliness of lake's shore, there is also the assessment of the state of the environment, urban discharges (quantity and composition), surface water discharges on each shore, as and all hygienic-sanitary factors affecting the level of microbiological pollution of shores.

The sampling was conducted in accordance with the World Health Organization Manual for bathing water and monitoring and quality assessment of beaches (WHO, 1995). The frequency of sampling was once a month. 100 ml sterile plastic bottles were used for bacteriological analysis of shore samples.
In our study to assess the water quality of selected lake's shore, some important microorganisms were identified and identified. Such are coliforms, intestinal enterococci, salmonella, shigella, yeast and fungi.
All bacteriological qualitative testing of water is based on the identification of sewage indicators such as *Escherichia coli* etc. A coliform is a facultative anaerobe that ferments lactose to produce gas and is a gram-negative, non-spore-forming rod. *Escherichia coli* fit this description. Note that three different tests are involved: presumptive, confirmed and completed. Each test exploits one or more of the characteristics of a coliform.

This study is performed from 2023 to 2024. We have analysed the samples from 3 sources near the Shkodra Lake. The water samples are collected in some stations. They are analysed for *E. coli*. The samples are collected in the different distances from the waterside: 5-7m, 50m and 200m. The samples are collected in the deep 20-25 cm from the lake's surface. All the samples are analysed at the Microbiological Laboratory. In addition to determining the presence or absence of coli-forms, we also have used the series of lactose broth tubes to determine the most probable number (MPN) to coli-forms present in 100 ml of water: Hyskaj (2007); Manual (1992).

The evaluation of the bacterial pollution is realized through the determination of *Escherichia coli*, which are the part of the faecal coliform and the general inhabitant of the gastrointestinal system. *E. coli* is considered as significant index for the pollution assessment compare with other microorganisms and at the same time it's a specific index of faecal pollution and the present of potential pathogen microorganisms.
The coli form group includes several genera and species of bacteria which have common biochemical and morphological attributes that include gram-negative, non-spore forming rods that ferment lactose in 24 to 48 hours at 35ºC. These attributes are found in *E. coli* which is the coli form of most sanitary significance as it is very common in the faeces of warm-blooded animals.

A subset of the coliform group of bacteria that is able to grow at 44.5ºC (thermo-tolerant coli-forms). Monitoring methods that employ elevated temperature incubation give a more specific estimate of the presence the number of *E. coli* and thus the presence of faecal contamination.
Ten grams of littoral samples were inoculated into 90 ml of Selenite-F broth and incubated at 37ºC for 24 h, after which the colonies were switched to DC terrain. Suspicious colonies from the Hajna and KIA terrains were identified by the respective serums (Baron & Finegold, 1990) at the Institute of Public Health, Tirana.

A 10-1 w/v suspension of littoral samples based on wet weight was prepared in the field 0.1% buffer peptone water. The enumeration was performed using the Dicloran Rose Bengal Chloramphenicol (DRBC) Agar field method. The dishes were incubated at 25ºC. The examination for the growth of yeasts and Molds was done after 3, 4, and 5 days of incubation. Peak colonies appear pink by absorption of Rose Bengal. For the identification of *Candida albicans* the suspicious colonies were transferred to the Saburo Dextrose Agar field. The identification of the main Molds was done through macroscopic and microscopic observation as well as the use of appropriate atlases. Results are reported as forming colony units (CFU) per gram or millilitre sample.

RESULTS AND DISCUSSION

Lake Shkodra has an area of 368 km2, of which 156 are located within the Albanian territory. Lake Shkodra is connected to the Buna River and the Adriatic Sea. During its flow, it is rich in wetlands and environments, which have high values. About 100 km from the sea lie rivers and alps with a very interesting environment in many

directions, which offer beauty and rare landscapes with the presence of alpine valleys and rivers, with clean waters, waterfalls, and alpine lakes. Also, the presence of rare biodiversity of vegetation, flora, and fauna, where the binomial meadows-magnificent alpine forests, constitute "lungs" and "green carpets" with colorful flowers in this unique community of Shkodra.

Fish species in Albania have been well studied and about 313 species have been recorded. Of these, 64 grew in freshwater and 249 are littoral species. The grouping of fish in the coastal lagoons of Albania is typical of the Mediterranean lagoons, divided into two groups: migratory fish and resident fish. Sparidae, Mugilid, Muraenidae, Soleidae, Anguillid, Belonid are the main groups of migratory fishes, while Gobiid, Cyprinodontidae, Atherinidae, Syngnathidae are the main groups of sedentary species - although some species in this group are also migratory. In Albania there is a well-developed traditional fishing activity, especially in the coastal lagoons, based on the fishermen's own organizations and their traditional knowledge. The shallow depth of the lagoons normally makes fishermen ply the area in small boats (littorals). The total area of lagoons along the Albanian coast used for fishing is about 10,000 ha. The lagoons have similar geomorphological characteristics with soft bottom sediments resting on compacted clays and organic material. Albania imports littoral aquaculture technology and products from Greece, mainly to produce sea bass and cod.

The ecosystem in this area presents a very high biodiversity, where we can mention 281 species of birds, 61 species of fish, 17 species of amphibians, 33 species of reptiles, 37 species of mammals, 39 species of mollusks and 122 species of plants.

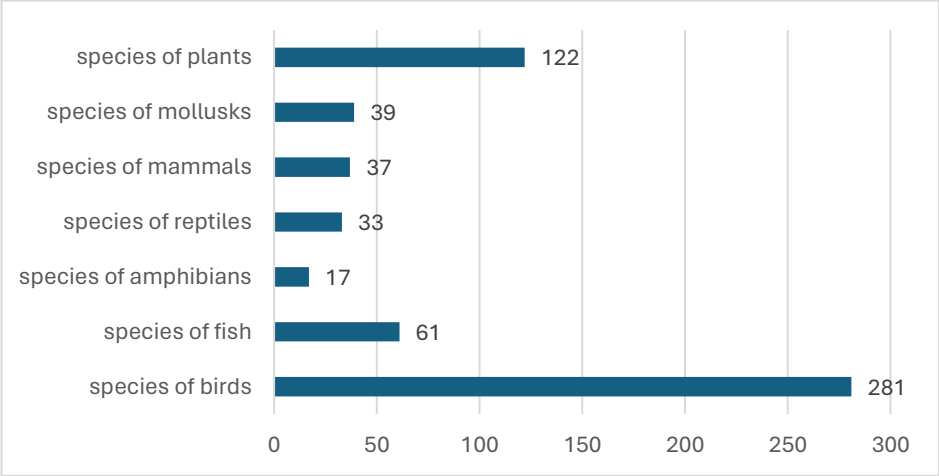

Figure 1. Biodiversity in Shkodra Lake

Some of the main risks identified in Shkodra Lake are: Domestic and solid waste, which pollutes the lake with various types of pollutants, especially plastic and glass, which have a long lifespan, turning this entire space into a swamp. watery. Meanwhile, chemical, and toxic waste from the industry is causing the death of fish species and serious genetic damage. The discharge of sewage on the shores of the lake is another negative phenomenon, which is excessively damaging the water through the growth of algae, the reduction of oxygen, the death of fish and other aquatic life.

From the confront of our results with the standards of WHO/UNEP for the water quality, which permit the values 100-1000 *E. coli* /100 ml water, we can stress that the most of our samples outnumber these standards and only some of them are inside of allowed values (figure 2).

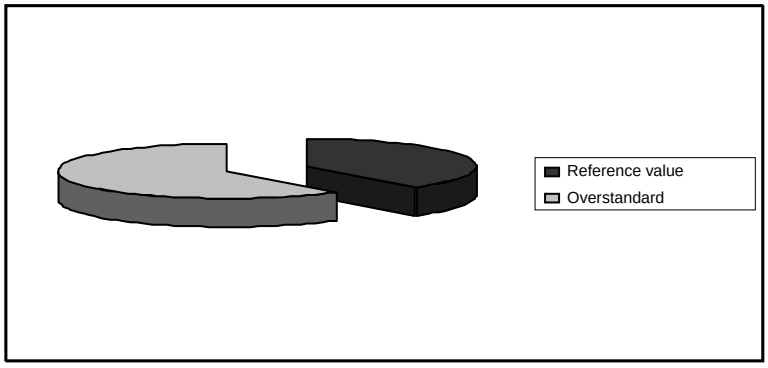

Figure 2. The percentage of the samples in and up standards of WHO/UNEP

For shore samples the quality assessment was based on the concentration of intestinal enterococci as they have a longer lifespan than fecal coliforms in littoral environments (Baron E & Finegold S, 1990) . The mean value of intestinal enterococci during the monitoring period at sampling points was 753 CFU / 100g. During the measurement period the number of intestinal enterococci ranged from 10 to 4100 CFU /100g.
The mean value of intestinal dry littoral sample enterococci during the monitoring period at sampling points was 676 CFU /100g. During the measurement period the number of intestinal enterococci ranged from 8 to 5000 CFU /100g.
The mean value of water sample fungi during the monitoring period at sampling points was 62 CFU /100ml. During this period, the number of yeasts and fungi ranged from 0 to 500 CFU / 100ml.
Since intestinal enterococci survive for a longer time in littoral environments than faecal coliforms, they were selected as the most suitable indicator for the evaluation of littoral samples based on the recommendations of the World Health Organization (WHO, 2005). Summary data for intestinal enterococci in littoral samples are presented in Table 1. During the monitoring period the bacterial concentration ranged from 10 CFU /100g to 4050 CFU / 100g. In the Table 1 we have shown the isolated bacteria from littoral environments. We have isolated *E. coli, Enterococcus spp., Staphylococcus spp., Pseudomonas aeruginosa, Salmonella spp., Campylobacter spp., Shigella spp.* The highest levels of intestinal enterococci were observed at the Station 1, where the average was 1373 (SD = 1522), while IE 95% was 4000. The average value of intestinal enterococci at Station 2 was 498 (SD = 484), while IE 95% was 1707. The mean in the Station 3 was 983 (SD = 1106), while IE 95% 3465.

Table 1. Isolated bacteria from littoral lake

Bacteria	Origins
Escherichia coli	Microorganism of enteric flora humans and animals. Humidity, temperature, UV rays and the concentration of organic carbon disintegrate affect the longevity of microorganisms.
Enterococcus spp.	Microorganism of enteric flora humans and animals. *Enterococcus spp*. resistant strains. are often isolated in the littoral of the beach
Staphylococcus spp.	Microorganism of the normal flora of humans and animals. They dominate the littoral
Pseudomonas aeruginosa	Environmental microorganism. It was isolated in all littoral samples
Salmonella spp., Campylobacter spp. Shigella spp.	They are discharged from human feces. Although isolated from samples of and animals, except Shigella, it is determined that they do not has human origins

Table 2. Intestinal enterococci in littoral samples according to monitoring stations

Location	No of Samples	Avr	SD	Min	Max	IE 95%
Stacion 1	20	498	484	90	2030	1707
Station 2	20	1373	1522	60	4100	4000
Station 3	20	983	1106	50	3600	3465

Avr-average, SD-Standard deviation, Min-minimum, Max-Maximum, IE 95% -Percentile 95

Based on Table 2 it turns out that the concentration of intestinal enterococci is in accordance with the norms and littoral of these shores turns out to have a suitable quality for attendance. This fact may indicate that littoral water is not the only cause of pollution, but pets, wild birds and even rainfall can cause pollution in the littoral of the shore. Table 3 below presents the results of Yeasts and Molds found at each sampling point in water samples, wet littoral, and dry littoral (Gentles JC). From the table it is seen that the samples of dry littoral have a higher concentration of Yeasts and Molds than the samples of wet littoral. Thus Bonadonna *et al*. (2002) reported a statistically significant correlation between yeasts and fungi and *E. coli* in an investigation on wet littoral and dry littoral in Italy. The most common genus of isolated yeast was *Candida sp*. During the monitoring period the concentration of *Candida sp*. ranged from 0 to 4500 CFU /100g, and the highest value (4500 CFU /100g) was presented by dry littoral samples at the Shkodra Lake stations. This value is four times higher than the allowable rate.

Table 3. Yeast and mold in water samples, wet littoral, and dry littoral

Stations	No of samples (n)	*Candida* ssp. (%)	Avr of Candida spp.	Amplitud of yeast (CFU/100g)	Fungi (%)	Avr of Fungi	Amplitud of Fungi (CFU/100g)
Station 1							
Wet littoral	15	15	20.0	$0-1{,}0.10^2$	25	40.0	0 $-2{,}0.10^2$
Dry littoral	15	35	150	$0-6{,}0.10^2$	65	4000	0 $-15{,}5.10^3$
Stacion 2 Wet littoral	15	25	40.0	$0-2{,}0.10^2$	35	400	0 $-3{,}6.10^3$
Dry littoral	15	25	500	$0-4{,}0.10^3$	60	300	0 $-1{,}3.10^3$
Station3 Wet littoral	15	35	30.0	$0-1{,}0.10^2$	20	40.0	0 $-2{,}0.10^2$
Dry littoral	15	35	60.0	$0-3{,}0.10^2$	30	220	0 $-1{,}5.10^3$

Number of samples analyzed (n), percentage of positive samples (%), mean and amplitude density of microorganisms.

Tabela 4. Parasites and fungi isolated from littoral environment.

Microorganisms	Source
Parasites: *Toxocara* spp., *Ankylostoma* spp., *Nocardioles*	Many parasites have been isolated from the littoral environment. Microorganisms which are discharged from the gastrointestinal tract of humans and animals.
Fungi: *Trichosporon* spp., *Candida* spp., *Trichophyton* spp., *Microsporum* spp, *Penicillium* spp., *Aspergillus* spp.	Fungi are often found in the shore and survive longer long compared to other microorganisms Fungi are classified as anthropophilic, zoophilic and geophilic

In terms of fungi, the most common isolated species were *Aspergillus sp.* (especially *A. niger, A. fumigatus*) and *Penicillium sp*. This high concentration of yeasts and molds can result in numerous infections such as skin, and especially vaginal infections in women during the summer season.

The growth of microorganisms in the littoral is limited by the lack of nutrients and competition with the native microbial flora. However, enterococci typically show tolerance to pH, temperatures, extreme salinity, and detergents.

Candida albicans and *Candida spp*. others have been isolated from the littoral of beaches in the south of France Buck, 1983). In the same study, 8 ceratinophilic fungi and 11 non-ceratinophilic species, all potential pathogens, were isolated (Soussa MLR, 1990). Were isolated 16 species of fungi from beach littoral along the northeastern Mediterranean coast of Spain, some of which were potentially pathogenic strains.
Candida species may be present in high numbers in immunocompromised, diabetic, or operative beachgoers. Candida species may be responsible for faecal contamination in both wet and dry littoral (Desmarais et al, 2002). Also, Yeasts and Molds generally show tolerance to salt. Vogel et al. (2007) showed that, while reproduction of yeasts and Molds in littoral was not intensive, intestinal yeasts could survive in littoral environments and 250 species of Candida were found in soil in warm areas.

The bacteriological pollution is in the high level compare with reference values of UNEP/WHO for the microbiology quality of the lake waters (100-1000 *E. coli*/100 ml water).. This fact is connected with the discharged of the sewage as well the high frequent of the vacationers during the summer. The highest values of the bacteriological pollution are in the samples which are collected near waterside (5-7 m) reducing 2-5 times in the distance 50 m from waterside, but again in the higher than the reference values. We can stress that the water in 200 m distance from waterside is clear bacteriological water.

The microbiological pollution situation has not any improvement because the polluted potential sources, such as discharged of sewage and not treated water is the same, unchanged. From the other side the constructions of many restaurants during the lake waterside increasing the quantity of the using water and the residue which are throw in the surround environment.

CONCLUSIONS

- Shkodra's lake ecosystem is under the effect of local climate changes. The tendency of small local climate changes in Shkodra's lake ecosystem can also damage the impact of global changes.
- The littoral of Shkodra Lake are easily basic and do not pose a risk to the health of visitors, also the turbidity of these beaches is low. This study also showed that the bacterial concentration is higher in wet littoral than in dry littoral environment.
- In terms of peaks and molds, the situation is particularly difficult in places where untreated urban waters flow. Compared to previous studies in our study, there was a decrease in the values of fecal indicators, but again these beaches are classified as shore of poor quality.
- Waste water from the settlements located in the watershed, especially on the shore, have distinct human impact on the water quality. Apart from this, we observed an improvement in the quality of water in Shkodra Lake. If this is a tendency, is very important for the people that visit this area during summertime. Nevertheless, there is still much work to do in order the water of this area become safe for bathing.
- The water near the sewage discharging, and next to frequently zones of the vacationers, present higher bacteriological load than the reference values of UNEP/WHO for the microbiological quality of the waters. This pollution is potential risk for public health, especially during the summer time. WHO recommended that 30 sort of infections can transmitted to people from polluted waters.
- We have not any epidemiological study to confirm the health risk from the washing in the polluted waters. We have a lot of cases with gastrointestinal diseases, skin and ears infections, especially at the children during the summer vacations. This is another argument for the necessary of the treatment of the sewage before their discharging in the lake.

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